# CHAPTER 16B

# EXTERIOR ELECTRICAL

## 16B-01 GENERAL

This chapter covers exterior electrical distribution systems, aerial and underground, and transformer stations.

Make an inspection of materials prior to installation for conformance with specifications, plans, and approved shop drawings. ENG Form 4288, Submittal Register, which lists approved materials, is essential to this inspection. Components for distribution systems will be inspected before they are installed and energized. Initial inspection and follow-up inspections will follow work as required by ER 1180-1-6.

## 16B-02 AERIAL DISTRIBUTION

a. Wood Poles

Note: If concrete or steel poles are provided be sure that the poles meet the strength and other criteria provided in the specifications.

(1) Check strength (class), length, conditions, and treatment of poles against design requirements. (A current edition of ANSI Standard 05.1, “Specifications and Dimensions for Wood Poles,” should be available to the inspector). Be sure that certification of compliance with applicable AWPA preservation specification has been submitted.

(2) Be sure that contractor*s provisions for storage and handling of poles are in accordance with specification requirements.

(3) Usually, specifications require poles to be full treated rather than butt treated. The preservation specification should be checked for verification.

(4) Poles should be turned, chamfered, trimmed, roofed, gained, and bored prior to pressure treatment. When field boring or gaining is necessary, additional preservation should be applied to bared surfaces.

(5) Examine type of handling tools.

(6) Be sure that gains have been made for all cross- arms.

(7) A site check of the pole line route and pole locations should be made to be sure that pole lengths furnished will be suitable to carry all intended circuits (including communications) and still maintain required vertical and horizontal clearances from the ground and other obstructions. (A current edition of ANSI-C2, National Electrical Safety Code, should be available to the inspector.)

(8) Be sure that the depths of pole holes are equal to minimum specification requirements, and that the width of each hole is adequate for backfilling and tamping in 6—inch lifts when required by the specifications. Surplus earth should be piled around the pole and tightly tamped to assist in drainage away from the pole and to compensate for shrinkage of the backfill.

(9) If design requires numbering of poles, see that this is done correctly.

(10) See that the grading of pole tops is even.

(11) When it is necessary to shorten a pole, see that the cut is made at the top and that it is treated with hot preservative.

b. Crossarms

(1) Check material meets specification requirements.

(2) Verify wooden crossarms use proper preservation treatment.

(3) Examine fastening.

(a) Inspect installation, bolting, setting angle, number, type and length of crossarm and secureness obtained.

(b) Check vertical spacing of multiple crossarms.

(c) Check pin hole spacing.

c. Hardware

(1) Be sure that all ferrous hardware (braces, bolts, lamps, pins, nuts, washers, screws, etc.) is standard pole line galvanized hardware.

(2) Be sure that all hardware is of the specified strength size and length.

(3) Be sure crossarm pins are of the specified strength and height.

(4) Bolts should not protrude more than approximately 2-inches or less than 1/8-inch beyond the nut.

d. Insulators

(1) Check furnished insulators against specification requirements.

(2) Inspect for damage.

(3) Check types and spacing of pins.

(4) Determine location of guy insulators.

e. Conductors (Aerial)

(1) Compare furnished supports with plans and specifications:

(a) Stranded or solid.

(b) Copper, aluminum, or combinations of copper and steel of aluminum and steel sized according to the specifications.

(c) Bare, weatherproof covered, or insulated conductors. Insure that insulation meets the project specifications.

(d) If messengers are used to support cables check to see that the are sized, attached and grounded properly.

(2) Check during installation:

(a) Tree trimming.

(b) Line Sag and Tension are within the specified requirements of the contract or NESC.

(c) Handling Watch for methods which will produce twists, kinks, abrasions, or cuts.

(d) Method of dead ending.

(e) Connectors and treatment of conductors at connectors or splices.

(f) Armor rod and/or armor tapes on aluminum conductors at supports.

(g) Tie wires and methods of securing conductors to insulators.

(h) Installations requiring racks and utilization of same.

(i) Horizontal and vertical clearance between conductors (ANSI C2).

(j) Installation and location of drip loops.

(k) Connectors on service drops - If dissimilar metals are connected be sure that approved connector is used.

(l) Dead ending with approved clamps with strength not less than that of the conductor.

(m) Area requiring special protection.

(n) Requirements for neutrals.

f. Giving

(1) Compare the type of guy with its intended use.

(2) Check type and size of anchors against ground conditions.

(3) Check materials to be used especially in areas where anchor rod corrosion may be a problem.

(a) Check for protective thimbles and thimble eye bolts.

(b) Examine three-bolt clamps at guy terminals.

(4) Check during installation:

(a) Anchor distance from poles (Anchor and guy strength is based on 1 to 1 slope. If the distance between pole and anchor rods has to be decreased, strengths must be increased)

(b) Location of guy insulator if required.

(c) Point of attachment on pole.

(d) Installation of rock anchors.

(e) Location of expansion anchors and log anchor rods.

(f) Need for additional guys.

(g) Installation of guy protectors.

(h) Gaining of poles for push braces.

(i) Identification of primary phases stamped on all transition poles and at all substations entering and leaving.

(j) Length of anchor rods.

(k) Grounding and bonding of guys when specified.

(l) Guy markers are in place.

g. Transformers

(1) Check method of mounting:

(a) Determine capacity of transformer or banks of transformers.

(b) See if method of mounting is similar to adjacent connected system, and notify supervisor of deviation.

(2) Check materials:

(a) Conformance with applicable ANSI and IEEE Standards.

(b) Primary and secondary voltage rating, kva capacity, and taps.

(c) Applicable ANSI and IEEE Standards for accessories of different capacity transformers, such as thermometers, liquid level indicators, liquid sampling devices, external tap changers.

(d) Transformer hangers for rigid mounting on the crossarms.

(e) Transformer bushings for rigid mounting with no evidence of cracks of chips.

(f) Transformer tanks for pin hole leaks.

(g) Impulse test certification if required by specification.

(3) Check during installation:

(a) Correct tap setting.

(b) Even distribution of weight of transformer banks.

(c) Mounting, crossmans, braces, wiring on pole mounting of H frame mountings.

(d) Primary and secondary connections.

(e) Grounding of transformer tanks.

(f) Rating of protective fuses.

(g) Accessibility of fused cutouts on pole.

(h) Type of electrical connections.

(i) Fused cutouts and lightning arrestors installed on the primary side of each transformer supplied from an exterior distribution system.

h. Primary and Secondary Fuse Cutouts

(l) See that approved type is used. Is it indicating or dropout; enclosed or open?

(2) Check current and voltage rating and short circuit interrupting capacity against design requirements.

(3) Be sure fuse links are of the capacity and delay specified and that they do not exceed the capacity of connected conductors. (Capacity tables for conductors may be found in NFPA Handbook 70, National Electrical Code).

(4) Check connection points of line conductors and load conductors.

(5) Examine type of bracket. Be sure bracket is secure, clear of adjoining structure, and convenient for operation.

i. Lightning Arrestors

Check:

(1) Location.

(2) Voltage rating and type against specification requirement.

(3) Mounting bracket.

(4) Grounding connectors.

(5) Ground resistance prior to energizing the line.

(6) Arrestors are not used as insulators to support conductors.

j. Pole Top Switches

(1) Compare switches with approval, making sure that correct current and voltage rated ones are used.

(2) Assure that contact surfaces will operate under ice conditions.

(3) Watch arcing horns for contact during operation.

(4) See that operating rods are provided with an insulator in the rod if specified.

(5) Make sure operating handle is equipped with lock and keys. If interlocking keying is specified, be sure it is furnished. Check out interlocking.

(6) Examine location of operating handle for convenience and safety.

k. Grounding

(1) Check type of ground conductors against design.

(2) Inspect exothermic welded ground connections for size rod, connector and powder charge against manufacturer*s recommendations.

(3) verify that ground rods are properly spaced relative to the pole.

(4) Examine mechanical grounding connectors.

(5) Check connectors to aluminum conductors. Connectors must be approved for aluminum.

(6) See that grounding conductors are protected from mechanical injury.

(7) Determine and record ground resistance; also determine need for additional ground rods.

(8) Record driven depth of ground rods.

(9) Insure that all noncurrent carrying metal parts on pole are grounded when specified.

(10) Check for separate grounding conductors and rods for lightning arrestor and equipment when required by specifications.

l. Street Lighting

(1) Examine all street lighting components.

(a) Check lighting bracket.

(b) When inspecting fixtures watch for:

- Light diffusing pattern.
- Open or enclosed type.
- Gaskets to protect the globe.
- Film cutouts on series systems.
- Free access for maintenance.
- Insulating transformers.

(c) Inspect regulator for kw rating, input voltage, and output current.

(d) Verify protector and control equipment voltage rating.

(2) Check during installation:

(a) Height of fixture.

(b) Lightning arrestors and fused cutouts installed on each phase of the supply to the protector.

(c) All ferrous surfaces hot dip galvanized.

(d) Each fixture will be secured with required number of through bolts of correct size.

(e) All metallic poles or standards.

m. Underground Risers

(1) Examine conduit clamps for size and number.

(2) Check duct seal at the conduit terminations.

(3) Look for listed insulated bushings at the conduit termination.

(4) Check cable terminations.

(5) Inspect during installation:

(a) Lag screws used on the conduit clamps.

(b) Cable supports to eliminate weight on the cable terminations.

(c) Metallic conduit below grade has approved protective finish as required.

(d) Stress cones on shielded cable.

(e) Safe climbing space.

16B-03 UNDERGROUND DISTRIBUTION

a. Duct System

(1) Check:

(a) Materials

(b) Method of encasement

(c) Painting

(d) Duct supports and spacers for size to maintain duct spacing.

(2) Check during installation:

(a) End bells and bushings at duct terminations.

(b) Ground bushings at all conduit terminations.

(c) Strength of concrete and presence of reinforcing steel where required under roads, paved areas, etc.

(d) Compacted subgrade.

(e) Spacers and spacing between ducts and minimum concrete cover all sides of ductbank.

(f) Spacing between electric and signal ducts.

(g) Alignment and grade of conduits, especially during encasement with concrete.

(h) Staggering of conduit joints.

(i) Adapters for joining dissimilar types of duct (see that they are not field fabricated)

(j) Changes in direction made with factory fabricated devices.

(k) Ducts secured in the forms.

(l) Ducts pitched to drain.

(m) Duct plugs used during construction and on all spare ducts.

(n) Cleaning of ducts.

(o) Seal duct entrances into manholes.

(p) Cover over ducts.

(q) Pull wires in place.

(r) Minimum curve radius of duct line in accordance with specification.

(s) Installation of marker if required by specifications.

b. Manholes, Handholes. and Underground Vaults

(1) Verify size according to specifications.

(2) Check that duct entrances are located to avoid sharp cable bends or sufficient space is allotted to permit a reverse cable bend.

(3) Determine strength of concrete.

(4) Check quantity and size of reinforcing steel.

(5) Check strength of cover and frame, marking of cover, and machine finished joint between frame and cover.

(6) Be sure that approved cable racks, pulling irons, steps, ground rod, etc., are provided in the specified quantity.

(7) Check during installation:

(a) Sequence of concrete placement (Construction joints are undesirable between the base and walls.)

(b) Seal around duct entrances and plug unused ducts.

(c) Pull irons are located opposite duct entrances.

(d) Waterproofing.

(e) Sump or drain.

(f) Quantity and location of cable racks, hooks, and insulators.

(g) Ground rod and ground cable.

(h) Grounding of cable racks and lead cable sheaths.

c. Primary Cables

(1) Inspect splicing kits and methods.

(2) Check qualification of cable splicer.

(3) Check cables for insulation, shielding, stranding, jacket or sheath and voltage rating.

(4) Examine potheads and pothead compounds.

(5) Check during installation that proper cable limits, pulling techniques and equipment are used to prevent cable damage.

(a) Type of pulling compounds: Verify that the compound is compatible with the cable and does not affect the flame retardation of the cable.

(b) Setup of reels (Do not kink).

(c) Cables sealed for pulling.

(d) Abrasion to sheaths on manhole frames.

(e) Even tension used in cable pulling.

(f) Cable routing in manhole.

(g) Splicing or terminating of cable.

(h) Conductor identification tags.

(i) Stress cones at splices and terminations.

(j) Ground shielding at splices and potheads.

(k) Abrasion or damage to cable by dragging on ground.

(l) Fireproofing cables in manhole when specified.

(m) Required tests.

d. Direct Burial Cable

(1) Verify cable burial depth.

(2) Check protective covering or armor. Check manufacturer*s designation for use. Compare material with approval data.

(3) Check during installation:

(a) Type of bedding and covering (should be smooth and free of stones and sharp objects)

(b) Use of untreated plank over cable when specified.

(c) Method of laying.

(d) Weaving of cable in trench.

(a) Radius of bends.

(f) Splices (minimization).

(g) Use of approved splicing kits.

(h) Installation of concrete cable markers with letter and arrow or tape markers as specified..

(i) Concrete encased conduits with bushings under traffic crossings.

(3) Spacing between cables.

(k) Compaction over cables.

a. Potheads

(1) Check size of the conductors or cables.

(2) Check stuffing box or wiping sleeve.

(3) Verify that compound is approved and installed as required.

(4) Make sure that installer is a qualified splicer.

(5) Check stress cones.

(6) Test compound for correct pouring temperature.

f. Transformers in Fenced Enclosures

(1) See that ferrous materials are protected with galvanized finish or are painted per specifications.

(2) Insure transformers, potheads, fused cutouts and lightning arrestors conform with the electrical characteristics specified and/or approved.

(3) Check installation of primary and secondary cabling for stress cones, waterproof connections, and insulators.

(4) Check during installation:

(a) Swing of gates.

(b) Drainage of transformer pad.

(c) Elevation of transformer off pad.

(d) Grounding of all noncurrent carrying metal within the enclosure.

(e) Grounding of the fence and gate.

(f) Proper grounding of primary (e.g. surge arresters) and secondary (e.g. neutral) equipment.

(g) Space available in transformer enclosure

(h) Bonding of all metal conduits terminating in the transformer enclosure to the ground system.

(i) Proper warning signs affixed to enclosure fence.

(j) Welds on fence structure are protected in accordance with specifications.

g. Pad Mounted Tranformers without Fenced Enclosures

(1) See 16B-02g, and 16B-03f.

(2) See that tamper proof enclosure has not exposed bolts, nuts, or fittings, the removal of which would give access to live internal parts and that meters, valves and other accessories are within locked enclosure or otherwise resistant to tampering, and that ventilation openings are so protected that a wire cannot be inserted to contact a live part.

(3) Verify that accessories, such as lightning arrestors, switches, gauges, etc., are furnished as specified.

h. Testing General discussion with the contractor on LOCK-OUT/TAG-OUTprocedure before any testing.

16B-04 CATHODIC PROTECTION

a. General

(1) Cathodic protection is provided to preserve underground or underwater metallic structures including submerged interior surface of water storage tanks from corrosion. Corrosion takes place at points where electrical current leaves the metal and travels through the ground or electrolyte to another metal or to a different place on the same pipe or structure. Corrosion is arrested when an electromotive force is impressed on an underground or underwater metallic structure in such a way as to make the entire structure cathodic with respect to the adjacent soil or water.

(2) Cathodic protection can be provided as described above or in the following manner: Sacrificial galvanic anodes are used having a difference of potential with respect to the structure to be protected. The anodes are made of a material, such as magnesium or zinc, which is anodic with respect to the protected structure. The galvanic — anode system is designed to deliver relatively small current from a large number of anodes.

(3) In addition to the following, complete the CP Acceptance Criteria during the Quality Assurance inspection.

b. Shop drawings

(1) The following items, if required in the work, must be approved prior to installation:

| | |
|---|---|
| Anodes | Electrical boxes |
| Conductors | Splicing materials |
| Rectifiers | Anode Hanger for tanks |
| Conduit | Transformer |

(2) Check material brought to the job site against approved shop drawings.

c. Anodes

(1) Be sure the anodes are not broken while being installed (Some anodes, such as duriron, are very brittle)

(2) Do not vary the spacing of the anodes more than 5% either way.

(3) The location of the anode bed should not be changed without consulting your supervisor.

(4) Be sure the anodes are installed in accordance with design and specifications.

d. Conductors

The insulation on the conductors must not be damaged during construction on impressed current systems. If it is damaged, the conductor may be soon be destroyed by electrolytic action.

e. Conductor Connections

Assure that joints are mechanically secure and that they are water tight.

f. Insulating Joints

Determine if insulating joints in pipe structures are required. Install in accordance with construction drawings. The insulating joints are used to accomplish the following: Isolate dissimilar metals; sectionalize pipe lines with dissimilar coatings; sectionalize one cathodic protection systems from another.

g. Bonding

(1) See that pipe joints are bonded (if called for in the contract) before the pipe line is backfilled.

(2) Be sure that bonds to other piping systems or structures are installed. If they are the resistor type, see that they are adjusted.

h. Test Points

Test points must be located exactly as shown on contract drawings.

i. Foreign Pipes and Structures

(1) Foreign pipes and structures may require cathodic protection.

(2) If you should discover, in the vicinity of the cathodic protection system, underground metal pipes or tanks that were unknown to the designer, bring them to your supervisor*s attention.

j. Backfill for Underground Metallic Structure

(1) Backfill of pipes and tanks must not contain rock or materials which would damage the coating on the structure or pipe.

(2) Check to see that only specified type of backfill is used. Cinder backfill should never he used.

k. Auxiliary Equipment

Check the installation of the rectifiers, transformers, conduit, and other electrical equipment using applicable parts of Chapter 16.

l. Electrical Measurements

(1) Impressed current system — Inform your supervision when the installation is complete.

(2) Sacrificial type anode system (using metallic anodes without external power supply) - Inform your supervisor when system is complete, prior to bonding the anodes to the structure.

m. Starting and Adjusting

Do not start the system to make adjustments. Request your supervisor or the CQC representative to obtain the services of one qualified in cathodic protection systems to perform these functions.

n. Record of Testing

Obtain a copy of the readings taken by the cathodic protection expert, including the potential measurements of the pipe before and after protection is applied, rectifier current and voltage readings for each set of potential measurements after the system is connected. These readings should be kept in the job records and turned over to the using agency when the work has been completed.

16B-05 ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)

When inspecting Energy Monitoring and Control Systems use Huntsville Division*s publication, CEHND-SP-91-005-DE-ME, April 1991 or as updated, Quality Verification Guidelines for EMCS. In order to provide the best product for the customers, the District*s Construction Division EMCS Technical Coordinator must be actively involved during the construction phase. Any questions which the Area/Resident Engineer cannot answer, should go to the technical Coordinator. The District can then call a Special Evaluation Group meeting to resolve any unusual or

precedent setting questions. All Value Engineering proposals presented during any phase of the project must be reviewed by the Mandatory Center of Expertise (MCX) for EMCS at Huntsville Division.

16B-08 RF SHIELDED FACILITY

Direct all questions which arise during the construction phase of a C41 (RF Shielded) facility to the Protective Design Mandatory Center of Expertise (PD-MCX)